

CLAIMS

1. A flexible active signal cable, comprising:
a flexible printed circuit substrate;
5 two electrical connectors; each located near one of two ends of the flexible printed circuit substrate;
at least two metal conductors connected at each end to one of the two electrical connectors;
at least one flexible optical waveguide affixed to the flexible printed
10 circuit substrate;
an optical transmitter optically coupled to one of the two ends of at least one of the at least one flexible optical waveguide and electrically coupled to one of the two electrical connectors; and
an optical receiver optically coupled to the other of the two ends of the
15 at least one of the at least one flexible optical waveguide and electrically coupled to the other of the electrical connectors.
2. The flexible active signal cable according to claim 1, where the flexible printed circuit substrate has no more than three electrically insulating layers.
- 20 3. The flexible active signal cable according to claim 1, wherein the optical transmitter and receiver are electrically connected, respectively, to the two electrical connectors.
- 25 4. The flexible active signal cable according to claim 1, further comprising at least one electrical parallel-to-serial converter that is electrically connected to the optical transmitter and electrically connected to one of the two electrical connectors.
- 30 5. The flexible active signal cable according to claim 1, further comprising at least one electrical serial-to-parallel converter that is electrically connected to the optical receiver and electrically connected to one of the two electrical connectors.

6. The flexible active signal cable according to claim 1, wherein the number of electrical conductors is no more than 20.
7. The flexible active signal cable according to claim 1, wherein a maximum supported data rate per flexible optical waveguide is at least 25 megabits per second.
8. The flexible active signal cable according to claim 1, wherein the longest of the at least one flexible optical waveguide and the at least two metal conductors is less than 0.5 meters and a total optical loss in each optical path comprising loss in the one of the at least one flexible optical waveguide and coupling losses between the at least one flexible optical waveguide and the optical transmitter and receiver coupled thereto is greater than 5 db between 650-850 nanometers.
9. The flexible active signal cable according to claim 8, wherein the total optical loss is greater than 10 db between 650-850 nanometers.
10. The flexible active signal cable according to claim 8, wherein the total optical loss is greater than 20 db between 650-850 nanometers.
11. The flexible active signal cable according to claim 1, wherein the at least one flexible optical waveguide comprises an optical fiber that is adhered to the flexible printed circuit substrate.
12. The flexible active signal cable according to claim 11, wherein the optical fiber comprises one of polymer and glass.
13. The flexible active signal cable according to claim 1, wherein the at least one flexible optical waveguide comprises a polymer waveguide fabricated with the flexible printed circuit substrate.
14. The flexible active signal cable according to claim 1, wherein the flexible printed circuit substrate comprises at least one of polyimides and polyesters.

15. The flexible active signal cable according to claim 1, wherein the flexible active signal cable can be wrapped and unwrapped from a 5 mm diameter mandrel 10,000 times with a probability of failure that is less than 100 parts per million at a test temperature.

16. The flexible active signal cable according to claim 1, wherein the optical transmitter is one of an LED, a laser diode, or a VCSEL device.

17. The flexible active signal cable according to claim 1, wherein the optical receiver is a photodiode or a phototransistor.

18. The flexible active signal cable according to claim 1, wherein active surfaces of each of the optical transmitter and optical receiver are in one of a parallel and perpendicular orientation with reference to a surface of the flexible printed circuit substrate.

19. An electronic device, comprising:
a flexible active signal cable that comprises a flexible printed circuit substrate to which there are affixed two electrical connectors separated by less than 0.5 meters, that further comprises at least one optical waveguide coupled to the electrical connectors through active transducers that can be powered through electrical conductors that are coupled to the two electrical connectors, wherein the two electrical connectors, the at least one optical waveguide, the active transducers, and the electrical conductors are affixed to the flexible printed circuit substrate; and

a source connector mated to one of the two electrical connectors, the source connector carrying a set of electrical signals having a maximum combined data throughput equal to or greater than 25 megabits per second (kbps) that is transmitted by one of the at least one optical waveguides from the one of the two electrical connectors to the other of the two electrical connectors.

20. The flexible active signal cable according to claim 19, wherein the flexible active signal cable is capable of being wrapped and unwrapped from a 5 millimeter diameter mandrel 10,000 times at a test temperature with a failure rate that is less than 100 parts per million.

5

21. A flexible active signal cable, comprising:

two electrical connectors separated by less than 0.5 meters that are affixed to a flexible printed circuit substrate;

at least one optical waveguide essentially spanning the two electrical connectors; and

a transducer at each of two ends of the flexible active signal cable that couples one of the two electrical connectors to an end of one of the at least one optical waveguide,

wherein one of the at least one optical waveguides transmits an optical signal that has a data throughput of at least 25 megabits per second transduced from electrical signals received at one of the two electrical connectors.

22. The flexible active signal cable according to claim 21, wherein the flexible active signal cable is capable of being wrapped and unwrapped from a 5 millimeter diameter mandrel 10,000 times at a test temperature with a failure rate less than 100 parts per million.

25